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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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Signed D. Mahoney

Dated 03 JUN 1999

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Request for the grant of a patent

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The Patent Office

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1. Your reference — RSJ05661GB

15 MAY 1998

2. Patent application number
(The Patent Office will fill in this part) — 9810551.3

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

The Welding Institute
Abington Hall
Abington
Cambridge
CB1 6AL

Patents ADP number *(if you know it)* — 7746260001

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — HEAT INSULATING PRODUCT AND METHOD

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

GILL JENNINGS & EVERY

Broadgate House
7 Eldon Street
London
EC2M 7LH

Patents ADP number *(if you know it)* — 745002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	6
Claim(s)	2
Abstract	
Drawing(s)	3 & 3

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. For the Applicant
Gill Jennings & Every

I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 15 May 1998

12. Name and daytime telephone number of person to contact in the United Kingdom

SKONE JAMES, Robert Edmund
0171 377 1377

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HEAT INSULATING PRODUCT AND METHOD

The invention relates to a heat insulating product and a method for producing the product.

There are many applications where heat insulation and in particular fire resistance is required. Important examples include fire walls and doors for buildings and ships, ceilings, walls and internal panels of trains and other vehicles and heat shields for high performance aircraft, for example leading edges of wings, noses and cones.

Various coating materials and the like have been proposed in the past to promote heat insulation in these applications but these have been found to be inefficient and/or non-cost effective and there is a need to provide a much cheaper but reliable heat insulating product.

In accordance with a first aspect of the present invention, a heat insulating product comprises mica granules held together by a ceramic binder.

In accordance with a second aspect of the present invention, a method of manufacturing a heat insulating product comprises mixing mica granules with a ceramic binder; and drying the mixture.

We have found that a very cost effective product can be obtained by utilizing a mixture of mica granules and a ceramic binder. This should be contrasted with known mica sheet made using a paper making process which is a very dense product. The new product will be much less dense than this sheet material with the result that heat insulation is promoted by virtue of the trapped air. Furthermore, the resultant product is very lightweight making it much easier to handle and can be utilized in a variety of forms depending upon the application.

In one form, the product is substantially rigid and can be handled rather like wood or the like so that it can be cut to required shapes. The product is relatively brittle and so typically will be sandwiched between load supporting sheets which are adhered to the product. These

load supporting sheets can comprise fibre reinforced material sheets, steel or any other material enabling the panel to function as a structural or semi-structural component.

In other applications, the product is adhered to the surface of an article. Thus, a substantially rigid product could be produced which is then adhered to the article or more conveniently the product is formed in-situ on the article, for example by moulding, or by spraying onto the article.

An important application for the product is with known sandwich structures. These typically comprise of a core material such as foamed metals, plastics, wood, endgrain balsa or a cellular honeycomb of metal, plastic or composite materials sandwiched between planar members such as phenolic glass laminates. These sandwich structures have considerable importance within structural engineering and are used extensively in aerospace and other industries since they provide key benefits over conventional materials including very low weight, high stiffness, durability and production cost savings. However, such sandwich structures do not generally operate above 170°C. If a product according to the invention is adhered to such a structure, this enables the structure to be operated at far higher temperatures in view of the very low conductivity of the product.

The product can be produced in a number of different thicknesses and consistency and can adhere to most surfaces including metal, wood and composites. The product can be moulded around complicated shapes and can be produced in very thin layers which are flexible. Glass fibre, and woven glass fibre can be used to reinforce the product if required. This is dependent on the thickness of the product and the binder used.

In principle, any ceramic binder could be used, such a binder typically comprising an alkali silicate with a filler such as alumina, magnesia, silica or other ceramic.

The preferred binder comprises the adhesive part of a two part binder such as a waterglass. Commercial examples of such a binder are Al/CS manufactured by Fortafix Limited, and Aremco 571. The Al/CS binder comprises a first part of sodium silicate and a second part of an alumina filler. We have found that a very good product is obtained by using the adhesive part only (without the filler) or possibly by replacing the filler with powdered mica.

The step of drying the mixture could be carried out by heating or any other drying method including vacuum drying, optionally assisted by the use of microwave radiation.

Examples of applications of the invention are set out below:

1. Fire walls and doors for buildings and ships.
2. Protecting surfaces that are near to a heat source i.e. exhaust manifolds on cars and trucks.
3. Cable industry where once asbestos materials were used.
4. Electronic motors, commutators, insulators.
5. Cabin and cargo holds for aircraft.
6. Ceilings, walls and internal panels of trains.
7. Heat shields on high performance aircraft i.e. leading edges of wings, noses, and cones.
8. Protection from solar or other radiant heating.

Tests have shown that the heat insulating product according to the invention has a number of important properties:

1. Thermal properties, mica can withstand heat up to temperature of 1000°C.
2. Resists fire without burning.
3. Low heat conductivity.
4. Insulating electrical properties better than 24kV/mm.
5. Permeability to microwaves.
6. Good resistance to arcing and arc erosion.
7. Mica is inert to most chemicals.

8. Mechanical properties are very good in particular compression resistance.
9. Good tensile and bending strength.
10. Large elasticity modulus.

These properties will vary depending upon the particular mixture of mica and binder which is used and these can be chosen depending upon the application.

Some examples of heat insulating products according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic cross-section through one example of a product incorporated onto a honeycomb structure;

Figure 2 illustrates the results of a fire test on the structure shown in Figure 1; and,

Figure 3 is a photograph of another example of the product.

Figure 1 illustrates a honeycomb core 1 made, for example, of aluminium in a conventional manner. This core is sandwiched between a pair of phenolic skins 2,3 which are adhered to the core 1. As explained previously, this sandwich structure does not have significant fire resistance and so to improve its fire resistance, a mica heat insulating layer 4 is provided on the phenolic skin 2. This was achieved in the following manner.

A conventional two part ceramic adhesive Al/CS was selected and 120 grams of the adhesive part (that is a waterglass) was mixed with 2 grams of powdered mica and 26 grams of mica granules. The powered mica took the place of the conventional aluminium filler which is normally used with the ceramic adhesive and is used in the same proportion as the filler.

The exposed surface of the phenolic skin 2 was degreased, this skin having dimensions of 150mm x 150mm x 12mm. 70 grams of an adhesive (Fortafix Al/CS)/powdered mica was applied onto the clean surface of the phenolic

skin or board 2 and the board was placed in a bonding jig with the adhesive surface face up.

The mixture of mica granules and adhesive was applied onto the precoated surface of the phenolic skin 2 to a thickness of about 8mm. A thin layer of powdered mica was then evenly spread over the exposed surface of this previously coated mixture and the resultant product was clamped over its entire area using a steel caul plate with release paper. The structure was then placed in a preheated oven for one hour at 60°C to bind the mica granules into the layer 4 and adhere that layer to the phenolic skin 2. In some cases, further improved properties can be obtained by using higher temperatures.

It should be understood that the provision of a thin layer of powdered mica over the surface of the layer 4 is optional as is the use of powdered mica in the earlier mixing process. It was found that the replacement of the powder filler or its omission from the binder provided a significant weight saving without adversely effecting the performance as well as providing a cost saving.

The performance of the structure shown in Figure 1 was assessed by placing thermocouples onto the structure at the positions shown in Figure 1. Series 1 thermocouple was placed on the surface of the phenolic skin 3, the series 2 thermocouple was placed between the phenolic skin 2 and the layer 4; and series 3 thermocouple was placed on the uncoated, external surface of the layer 4. As can be seen from Figure 2, the fire test showed that when a flame at 1000°C was placed on the exposed surface of the layer 4, the series 1 thermocouple indicated that the temperature on the opposite surface of the structure did not exceed 130°C for 15 minutes. The series 2 thermocouple indicates that the temperature between the layer 4 and the phenolic skin 2 did not exceed 220°C.

In view of the significant reduction in heat across the layer 4, conventional adhesives can be used to adhere that structure to the support surface.

Figure 3 illustrates another form of the product which has a substantially rigid structure and is self-supporting. This can be used as the core between load bearing boards or plates, for example made of mica (not shown). As can be seen in Figure 3, the product has substantial size and the granules are clearly visible, having a maximum dimension up to 15mm. The product can be handled in a similar way to wood as previously mentioned. This product has been formed by a moulding process and it will be clear that more complex shapes could also be achieved using appropriate moulds. This indicates the versatility of the invention.

CLAIMS

1. A heat insulating product comprising mica granules held together by a ceramic binder.

2. A product according to claim 1, wherein the product is substantially rigid.

3. A product according to claim 1 or claim 2, wherein the binder comprises the adhesive part of a two part binder.

4. A product according to claim 1 or claim 2, wherein the binder comprises the adhesive part of a two part binder, mixed with powdered mica.

5. A product according to any of the preceding claims, further comprising glass fibre reinforcement.

6. A product according to any of the preceding claims, wherein the mica granules have a maximum dimension up to 15mm.

7. A product according to any of the preceding claims, wherein the product is sandwiched between load supporting sheets adhered to the product.

8. A product according to any of the preceding claims adhered onto the surface of an article.

9. A product according to any of claims 1 to 6 moulded onto the surface of an article.

10. A product according to any of claims 1 to 6 sprayed onto the surface of the article.

11. A product according to claim 9 or claim 10, wherein the article comprises a honeycomb structure.

12. A product according to claim 11, further comprising a phenolic glass laminate sandwiched between the honeycomb structure and the product.

13. A heat insulating product substantially as hereinbefore described with reference to any of the examples shown in the accompanying drawings.

14. A fire wall comprising a heat insulating product according to any of the preceding claims.

15. A method of manufacturing a heat insulating product, the method comprising mixing mica granules with a ceramic binder; and drying the mixture.

16. A method according to claim 15, wherein the drying step comprises heating the mixture, or vacuum drying the mixture.

17. A method according to claim 15 or claim 16, wherein the mixture is held in a mould during the drying step.

18. A method according to claim 15 or claim 16, wherein the mixture is coated onto a surface of an article prior to the drying step.

19. A method of manufacturing a heat insulating product substantially as hereinbefore described with reference to any of the examples shown in the accompanying drawings.

HIGH TEMPERATURE FIRE RESISTANT SANDWICH PANEL

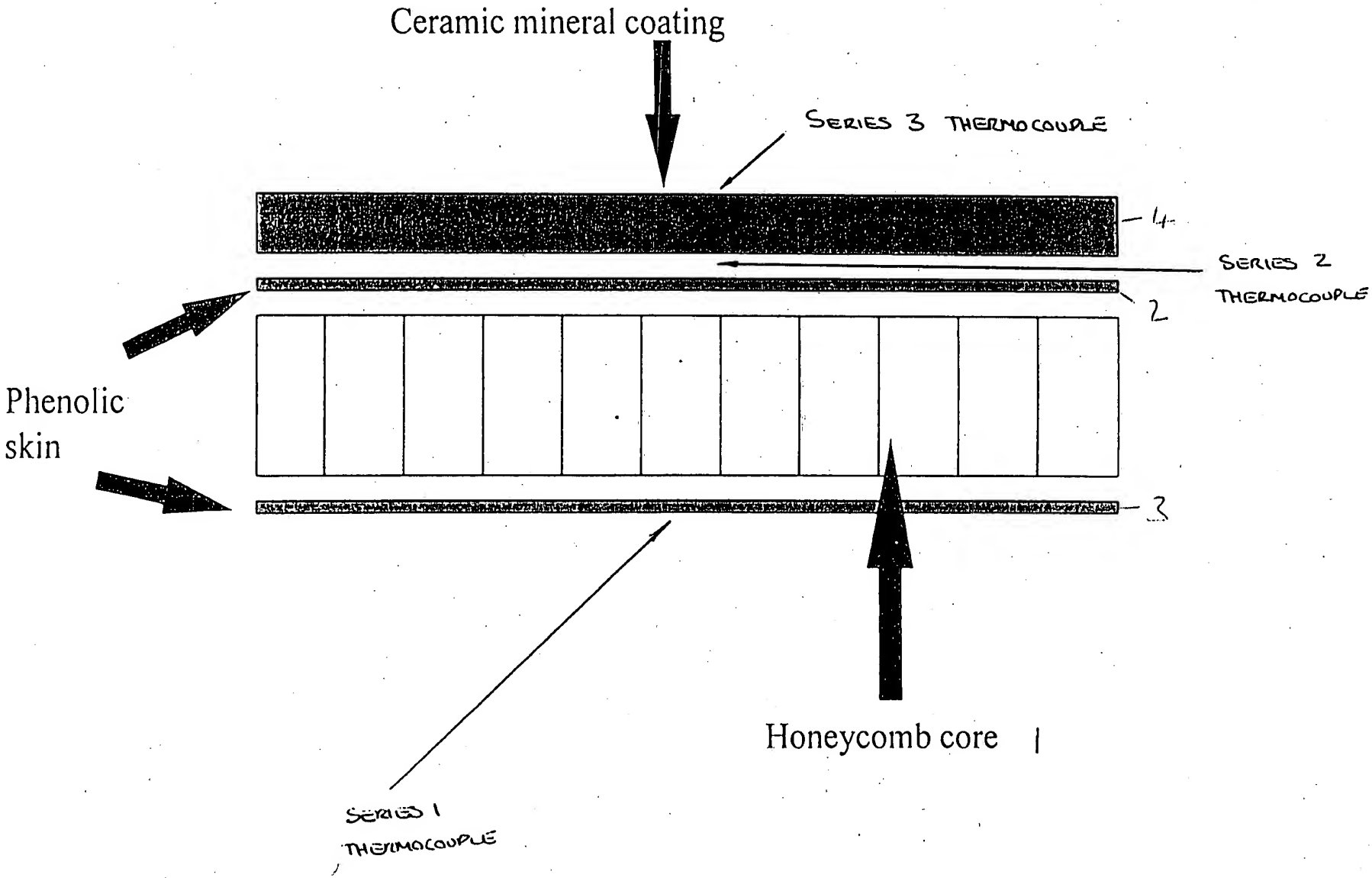
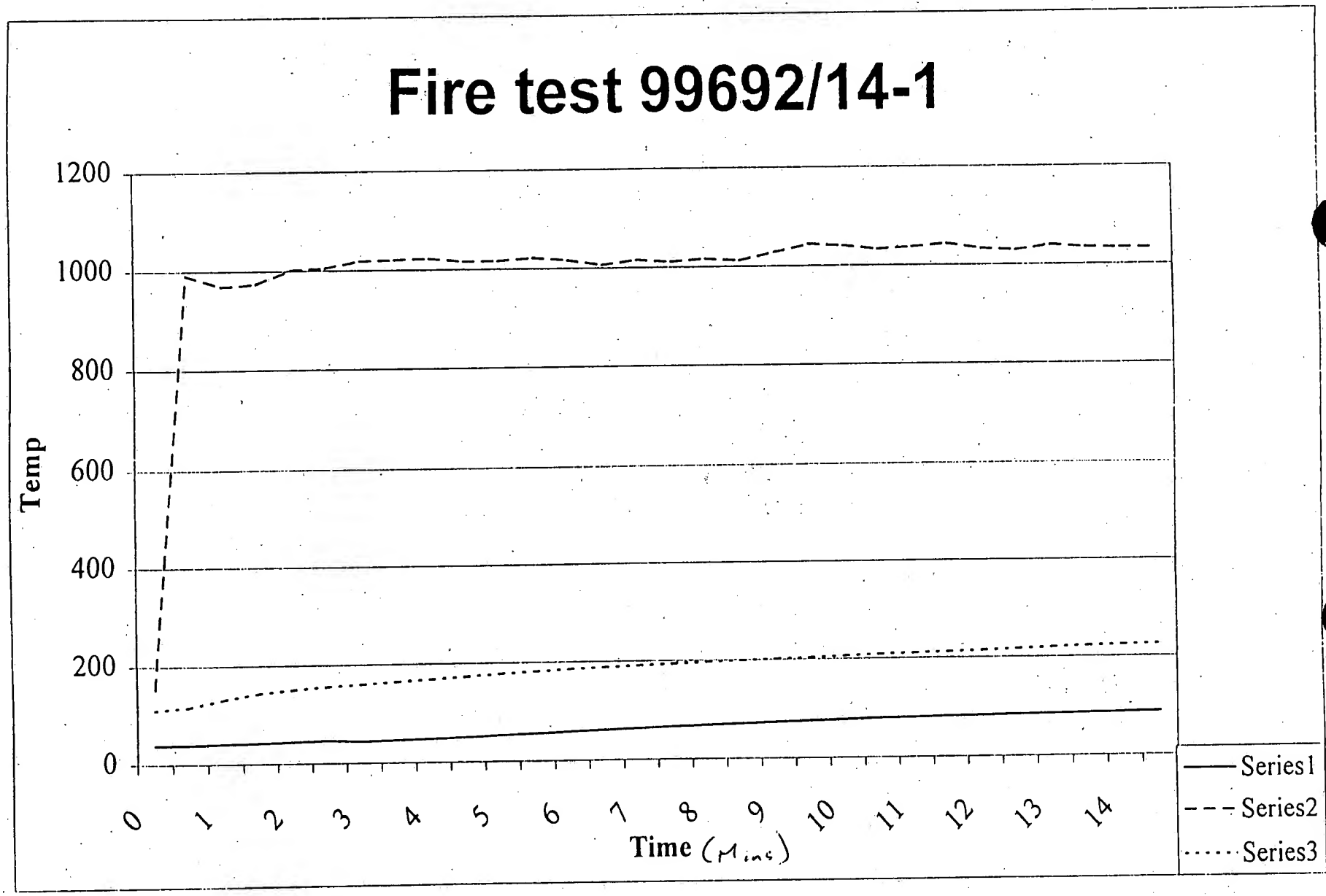


Figure 1


Fire test 99692/14-1
1200
1000
800
600
400
200
0
Temp
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1
2
3
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6
7
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Time (Mins)
Series1
Series2
Series3

FIG 2

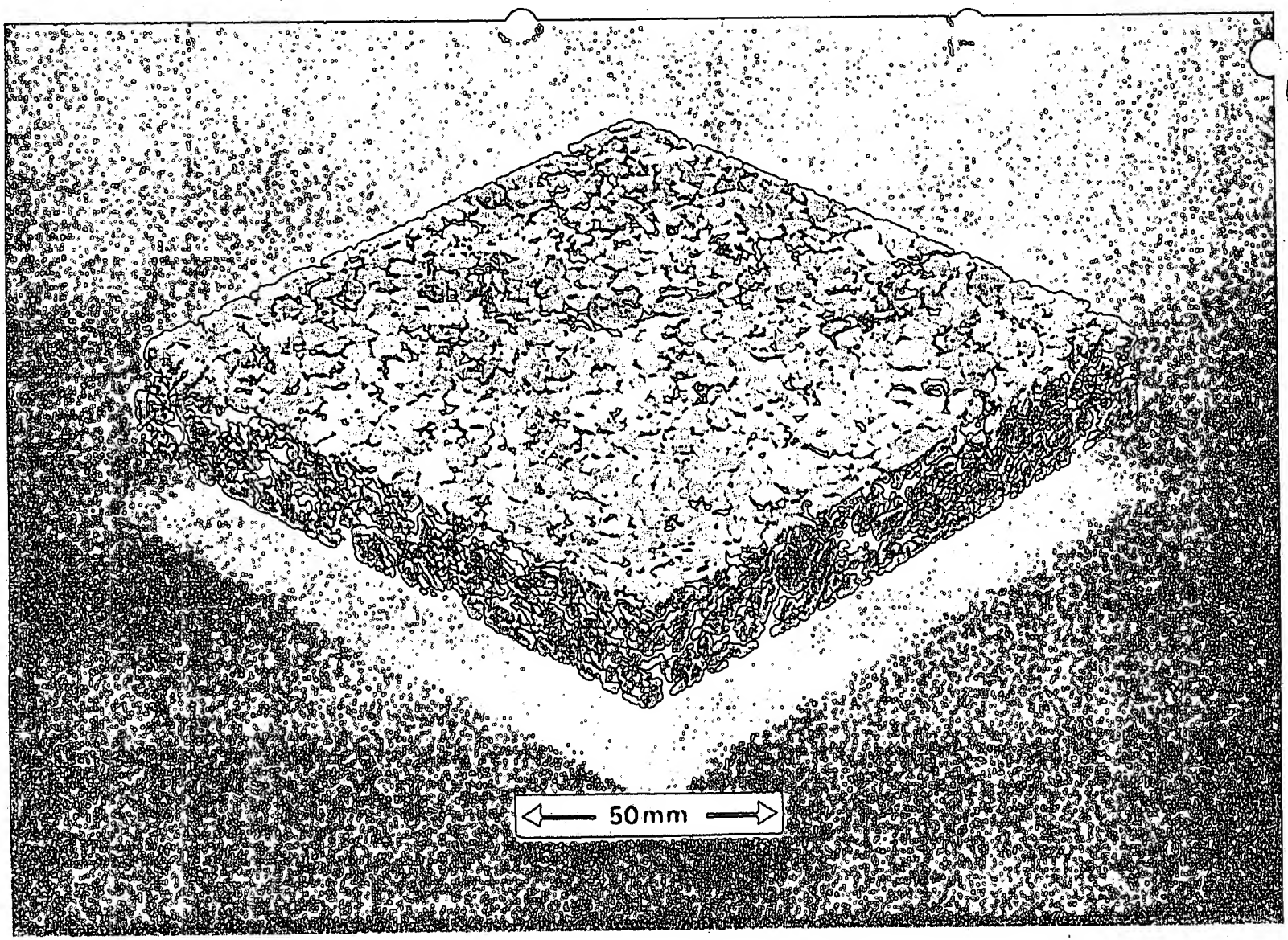

FIG 3

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